CLASSIFICATION CONFIDENTIAL CONFIDENTIAL

CENTRAL INTELLIGENCE AGENCY REPORT

INFORMATION FROM FOREIGN DOCUMENTS OR RADIO BROADCASTS CD NO.

50X1-HUM

COUNTRY USSR

SUBJECT Scientific - Metals

HOW PUBLISHED Thrice-monthly periodical

WHERE PUBLISHED Moscow

DATE PUBLISHED 21 Oct 1950

LANGUAGE Russian

DATE OF INFORMATION 1950

DATE DIST. 11 Jul 1951

NO. OF PAGES 3

SUPPLEMENT TO REPORT NO.

SOURCE Doklady Akademii Nauk SSSR, Vol LXXIV, No 6, 1950, pp 1085-1087.

THE NATURE OF MARTENSITE SEPARATED ELECTROLYTICALLY FROM HARDENED STEEL

M.P. Arbuzov, Metallophysics Laboratory
Academy of Sciences Ukrainian SSR
Submitted 26 August 1950
Submitted by Academician I.P. Bardin, 26 August 1950

In the process of studying crystal structure of the carbide phase, using powders of carbide separated from steels tempered at various temperatures (1, 2), it has been revealed that particles of alpha martensite are deposited on samples of hardened steels during their electrolytic dissolving. Thus, a method of anodic dissolving may be applied not only for separation of carbides from steels, but also for obtaining isolated martensite from hardened steel.

There are some reasons to assume that martensite separated from steel differs, by nature, from martensite distributed in steel and that the separated martensite may serve to clarify certain processes in the heat treatment of steels. In connection with this assumption, hardened steels with various carbon contents have been dissolved and deposits (martensite powders) have been studied by X-raying. This paper presents some results of the investigation.

Carbon steels with carbon contents of 0.80, 0.98, 1.16, 1.38 and 1.51% were used in the experiments, the carbon being determined with an accuracy of 0.03- 0.05%. Quenching was done from temperatures in the gamma zone.

An aqueous solution of hydrochloric acid or potassium chloride and citric acid was used for dissolving the hardened steel.

Radiograms were obtained in iron radiation from cylindrical specimens (1 mm diameter) pressed out of martensite deposits (powders). For comparison purposes, the radiograms were obtained under similar conditions from an ordinary cylindrical specimen made out of a solid chuck of hardened steel with 0.98% C.

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Annealed fine filings of pure iron served as a standard in determining reflection angles.

Results of dissolving and radiography of deposits obtained demonstrated that one of the basic conditions making possible the separation of martensite by anodic dissolving of steels is the presence of a second phase, residual austenite, in samples of hardened steel. Since the dissolving potentials of austenite and martensite differ, conditions for electrolysis may be selected under which only the gamma phase will be dissolved, and dissolving of martensite practically will not occur. As a result of such a process, a residue is formed on the surface of the sample to be dissolved. This residue gives on radiograms only the interferences of a martensitic tetragonal lattice.

There is a substantial difference between the radiograms taken from a solid sample of steel and those obtained from martensite powder of the same steel. Lines of the martensitic phase on the radiograms of solid samples are, as usual, diffuse to a great extent. The diffusion of lines was considerably less on all radiograms obtained from martensitic powders.

Difference in the width of lines indicates that a great diffusion of lines, specific to the martensite of hardened steel, is mainly due to a state of elastic deformation which is imposed on martensite crystals.

Upon the dissolving of austenite, the plates of martensite are relieved from the action of the surrounding elastic medium, deformation being removed to a considerable extent. The axial ratio of the tetragonal lattice remains unchanged (within the limits of error of the measurements). Disappearance of the intensive diffusion of martensite lines, due to electrolytic dissolving of austenite in which martensite was enclosed, proves that the elastic deformation of the martenite lattice is caused by forces exterior in regard to each crystal.

Thus, new experimental data have been obtained on the nature of the diffusion of martensite lines and the nature of so-called stresses of the second kind.

Measuring the constants and axial ratio (c/a) of the lattice of separated martensite demonstrated that their absolute values and also their dependence on the content of carbon in steel do not change in respect to martensite location, whether martensite is incorporated in steel or separated from it. This fact indicates directly that the tetragonal structure of martensite if by no means caused by stresses, as has been sometimes supposed. Furthermore, this fact shows that such a structure is a direct result of participation of the atoms of both components, iron and carbon (solid solution), in constructing the lattice of martensite, as follows from data of x-ray investigations (4).

The following table gives the values of lattice constants and axial ratios obtainted from radiograms of martensitic powders separated out of hardened steels with various carbon contents.

% C	a	c	c/a	c/a by Kurdyumov
0.80	2.854	2.953	1.035	1.037
0.98	2.852	2.973	1.042	1.0457
1.16	2.851	3.001	1.053	1.054
1.33	2.848	3.021	1.061	1.062
1.51	2.844	3.042	1.070	1.070

Such a relation between the axial ratio of the martensite lattice and the content of carbon in steel was obtained for the first time by G. V. Kurdyumov and E. Z. Kaminskiy (3). Later, on the basis of new experimental data, Kurdyumov expressed this relation as follows:

$$c/a = 1 + 0.0467\ p,$$

where p is percentage of carbon in steel by weight.

The table shows that values for c/a obtained by the author and those found from Kurdyumov's formula are in good agreement. Insignificant variance is, obviously, a result of inaccuracy in determining carbon and lattice constants.

Thus, experimental results permit the following conclusions:

1. The method of anodic dissolving of hardened steel may be used for separation of martensitic phases.

2. The crystal structure of martensite remains unchanged upon disolving of steel.

3. On separation of martensite, its crystals are considerably relieved of lattice distortions which cause the diffusion of interference lines (stresses of the second kind).

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